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ABSTRACT

The effects of three types of feedback in a computer-assisted instructional lesson--knowledge of the correctness of response (KOR), knowledge of the correct answer (KCR), and explanatory feedback in combination with or without a second try on error correction--were investigated, using a 2 by 3 factorial design. The results indicated that explanatory feedback was significantly superior to KOR feedback in improving immediate posttest achievement, and also significantly better than KCR feedback in reducing the probability of repeating a practice error on the delayed posttest. The "second try" factor had no significant impact on performance. One of the possible reasons for the insignificant results might be that learners did not maintain a high level of learning motivation due to the difficulty of the instruction. Future research is needed to determine what would be the sufficient amount of feedback information and appropriate difficulty level of the instruction that would maximize learning. (5 tables, 24 references) (Author/BBM)

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Title:

The Effects of Feedback and Second Try in Computer-assisted Instruction for Rule-learning Task

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Abstract

The effects of three types of feedback: knowledge of the correctness of response (KOR), knowledge of the correct answer (KCR) and explanatory feedback in combination with or without a second try on error correction in a computer-assisted instructional lesson were investigated, using a 2 by 3 factorial design. The results indicated that explanatory feedback was significantly superior over KOR feedback in improving immediate posttest achievement and also significantly better than KCR feedback in reducing the probability of repeating a practice error on the delayed posttest. The "second try" factor had no significant impact on performance. One of the possible reasons for the insignificant results might be that learners did not maintain a high level of learning motivation due to the difficulty of the instruction. Future research is needed to determine what would be the sufficient amount of feedback information and appropriate difficulty level of the instruction that would maximize learning.

The Effects of Feedback and Second Try in Computer-Assisted Instruction for a Rule-Learning Task

In the past decade educators have emphasized the importance of making instruction more sensitive and responsive to the individual learner. Educators often argue that instruction should be developed in a manner which provides the availability of as much time and resources as required by the learner to attain the learning goal. Computer-assisted instruction (CAI) has been considered as a valuable individualized instructional systems to meet these time and resource demands. The key reason for this belief is because CAI can be designed to individualize the instructional process in a way which can adapt the instruction to each student's individual and changing differences in terms of needs and abilities. One of the ways that CAI can accommodate the individual needs of the learner is to provide feedback to learners as to the adequacy of their performance.

Function of Feedback

Feedback can be employed to communicate with the learner about the adequacy of his performance and, therefore, is crucial for learning. Unfortunately, its mechanism in learning has not been unequivocally determined. For a long time, behavioristically oriented theorists (Skinner, 1961, 1968; Throndike, 1931) tended to assign a reinforcing mechanism to feedback. In contrast, recently, a number of psychologists have pointed out that feedback should be informative and corrective and has a more facilitating effect as error correction than as a reinforcement of correct response (Ausubel 1968; Kulhavy, 1977). Furthermore, Gagne (1987) asserted that feedback functions as a mechanism for supporting effective storage of infomation into memory.

Various studies have investigated whether it is the reinforcing or informational characteristics of feedback that facilitates learning. The research results have repeatedly confirmed that the functioning of feedback in learning is informational, rather than reinforcing (Buss & Buss, 1956; More and Smith 1965; Sassenrath, 1975).

Types of Feedback and Their Effects

Many researchers prefer to treat feedback as a unitary instructional variable, while some indicate that feedback should be classified into various categories based on its instructional purposes. For instance, Kulhavy (1977) pointed that feedback can be regarded as a "continuum" which can range from the simplest confirmational format to the presentation of remedial information or even new instructional materials.

A number of researchers further believe that the different natures and amounts of feedback information have differential influence on learning (Carter, 1984; Gilman, 1969; Roberts & Parks, 1984; Roper,1977). As Carter (1984) reported, feedback is usually constructed into four forms including (a) knowledge of response (KOR) feedback, which contains simplest message such as "correct", or "incorrect" only, (b) knowledge of the correct answer (KCR) feedback, which informs the learner as to what the correct answer is, (c) corrective feedback, which states why an incorrect response is erroneous and why a correct response is right and (d) various embellishments of these three basic types.

Several studies have been conducted to investigate the effectiveness of different types of feedback in order to determine how much information and what

kind of information should be contained in feedback. Gilman (1969) examined the effects of five types of feedback (no feedback, KOR, KCR, corrective and a combination of KOR, KCR and corrective feedback) in a CAI lesson dealing with commonly misunderstood science concepts. The results revealed that the most detailed feedback information yielded the best results (i.e., the number of correct responses in posttest). Also revealed in Gilman's study was that KCR, corrective or a combination of KOR, KCR and corrective feedback produced better effects upon immediate retention than did no feedback or KOR feedback. Research results which favored feedback with increased information have also been conducted by Roper (1977) and Roberts and Park (1984). In Roper's study, the effects of no feedback, KOR, and KOR feedback plus the correct answer stated in the context of the question were investigated. Roper found that KOR feedback coupled with the correct answer resulted in the best achievement on the posttest and no feedback was the least effective feedback condition. Roberts and Park (1984) studied the interaction between different amount of feedback information and learners' cognitive styles. In their studies,learners were classified as field dependent or field independent and received a CAI lesson along with either KOR or explanatory feedback. They found that learners receiving explanatory feedback performed better on both the immediate posttest and the delayed retention test than those who received KOR feedback, regardless of their cognitive styles.However, with respect to the effect of feedback with additional information, there are other studies that have failed to yield consistent results. For example, the study by Steinberg (1981) did not reveal significant differences among no feedback, KOR feedback and KOR feedback plus additional explanation. Further, there is little consensus on precisely how much information should be contained in feedback so as to promote learning. Phye (1979) tested the prediction that the greatest amount of feedback information would produce the best immediate and delayed retention effects. Unexpectedly, he found that the minimal feedback information brought the greatest retention improvement on the posttest. According to Phye, a possible explanation for such a contradictory result may be that too much or too detailed information seems to confuse learners.

Number of Tries

In a CAI lesson, second try opportunity is occasionally provided after an incorrect response for the purpose of supplying learners an opportunity in which they can correct an previous error and further employ their corrected mental structure to determine the correct answer. Unfortunately, however, only a few studies have investigated whether the provision of a second try opportunity upon an missed question facilitates learning. For instance, Hodes (1984) investigated the effects of corrective feedback, which informed an incorrect response as wrong, gave an corrective opportunity on the missed question and provided supportive encouragement to try the missed question again, and noncorrective feedback, which only informed an incorrect response as wrong. The results showed that corrective feedback and noncorrective feedback did not yield differential effects upon retention.

The Purpose of Study

This study was concerned mainly with how different types of feedback including

KOR feedback with a simple confirmational message, KCR feedback with the correct answer and explanatory feedback with the corrective information tied with one or two number of tries worked in correcting errors. Primary questions addressed in this study were: (a) What are the comparative benefits of KOR, KCR and explanatory feedback following an error during practice on posttest performance? (b) Does a second try as opposed to a single try provided following an error during practice promote error correction on posttests? and (c) Is there an interaction effect between level of feedback and number of tries?

Method

Participants

One hundred and sixty undergraduate preservice teachers from a southwestern university participated in this study. Among them, 90 percent were female. A pretest was administered to all participants as to (a) determine their prior knowledge of BASIC, which was the content taught in the experiment, and (b) use pretest scores to match students during assignment for treatments in order to reduce the possibility of initial group differences. Participants were grouped into high, medium, and low prior knowledge groups according to their performance on the pretest, creating stratefied random assignment of students to groups. Participants in each of these three groups then were randomly assigned to one of the six treatments. The results from the pretest showed that more than ninety percent of the participants were considered as low prior knowledge students. Consequently, in each of the six treatments, there were only two to three participants who were considered as high or medium prior knowledge students.

With regard to attrition, one student did not take the immediate posttest and twenty- eight students did not return for the delayed posttest. An examination of immediate posttest scores did not yield any indication that attrition was biased by any particular treatment. One error occurred during recording data on to the diskettes. As a result, only one hundred and thirty students successfully finished the experiment.

Independent Variables

Types of feedback and number of tries were the two independent variables involved in this study.

Types of feedback. Specifically, KOR feedback conveyed the simplest type of feedback information to learners. It merely informed the learner whether his response was correct or not. For example, KOR feedback after a correct response was "You are right" and KOR feedback after an incorrect response was "You are wrong". KCR feedback stated the correct answer regardless of the correctness or incorrectness of the response. For example, KCR feedback given after an incorrect response was "The correct answer is ... ". Explanatory feedback included KOR feedback to inform whether a response was correct or not and told the learner why an incorrect response was erroneous. In the case of an incorrect response, the learner could be informed of an error and realized why he made such an error through studying the content of the explanatory feedback. In this study, explanatory feedback never stated what the correct answer was. Primarily, it was used to provide the corrective information that enabled the learner to correct himself or served as a form of remedial instruction .

One and two tries. A single try was provided when the practice question was answered correctly. In contrast, a second try opportunity was given following an incorrect response. It was given to provide a second chance for learners to correct their errors, i.e. eliminate incorrect response and figure out what the correct response should be.

Dependent Variables

The dependent variables were immediate posttest scores, delayed posttest scores and attitude questionnaire scores. Both immediate and posttest test scores involved : (a) overall correct responses on a posttest, (b) conditional probability of a correct response on an item on a posttest given that an incorrect response was made on a similar item during practice, and (c) conditional probability of an incorrect response on an item on a posttest given that an incorrect response was made on a similar item during practice. Attitude questionnaire scores involved a rating of learners' attitude toward the instruction, as measured by an attitude questionnaire.

Design and Treatments

The effects of two independent variables on three dependent variables were investigated through using a 2 * 3 factorial design. There were six treatments in this study, and among these treatments different types of feedback and a second try opportunity were given only after incorrect responses. Specifically, treatment 1, 2, and 3 provided different types of feedback (KOR, KCR or explanatory feedback), but all of them provided only one try for a missed practice question. Treatment 4, 5, 6 provided different type of feedback (KOR, KCR or explanatory feedback), but all of them provided a second try for a missed practice question. In treatment one through treatment six, whenever a correct response was produced, learners received KOR feedback stating "You are right." and were not asked to do the question again.

Materials

The instructional material used in this study was a CAI lesson on BASIC programming language, which was originally designed by Spock (1987) and systematically modified by the experimenter so that it matched the treatments for this study. The CAI lesson consisted of three submodules: (a) a brief introduction on what makes up a BASIC program; (b) instruction on variables and constants with four practice questions; (c) instruction on LET, PRINT, and INPUT statements of BASIC and two examples and practice questions included in the instruction for each statement. At the end of submodule (c), five practice questions were provided, which related to the use of LET, INPUT, and PRINT statements simultaneously in a BASIC program. Feedback which represented the treatments were provided after all the practice items involved in the three submodules of the CAI lesson.

All the practice questions were multiple-choice questions. They actually questioned students about common misconceptions held by computer novices regarding the LET, PRINT, and INPUT statements in BASIC (Mayer, 1976). Each question contained five distractors with one correct answer. The student was informed to choose the single correct answer from the five distractors. However, all distractors were designed to be equally plausible, so that answering correctly would not be simply a matter of eliminating highly

implausible distractors. All the questions were designed to be difficult enough so as to make feedback yield effect. If the practice questions were too easy, learners might never make mistakes. If this was the case, learners might not need any feedback information to confirm if they have reached the goal of learning or to correct their mistakes. In such a situation, feedback would become useless.

Assessment Instruments

The assessment instruments included: (a) a pretest of 15 questions for grouping subjects into high, medium, and low prior knowledge groups; (b) an immediate posttest of 15 questions to measure learning achievement; (c) a delayed posttest of 15 questions for evaluating retention; (d) a questionnaire for asking subjects' attitude towards the instruction.

Except for the questionnaire, questions contained in the pretest, immediate posttest and delayed posttest were multiple-choice questions with five distractors and one correct answer. The tests were parallel, rather than identified test forms. The test items were similar across the pretest, immediate posttest and delayed posttest, each item reflecting a specific learning objective. In this study, the reason for using multiple-choice questions was that, multiple-choice questions were functionally appropriate for assessing rule-learning performance because the distractors involved in the questions could be constructed in such a way that learners were required to respond to more than one concrete instance of the rule. In addition, the distractors could be designed in a way that they served as cues for activating the recall of the previously learned concepts that make up the rule. Also, the great advantage of computers in administering multiple choice questions was that each distractor could be composed to represent a common misconception regarding application of a particular rule or concept, and the feedback could then be constructed to address that particular misconception.

Content Validity

To ensure the content validity of the pretest and two posttests used in this study, all the test items were designed to sample a representative portion of the subject content. The content validity of the pretest and two posttests used in this study were established by the following steps:

1. Prior to the pilot study, all test items were first reviewed by a professor, who teaches BASIC programming language at a southwestern university. All test items then were revised or rephrased according to his suggestions after the pilot study.

2. Two content specialists (one Ph. D., one Ph. D. candidate) in the field of Instructional Technology were asked to rate the relevance of the revised test items to the objectives identified in the task analysis. Both specialists were asked to use a 4-point scale ranging from *"not relevant (1)", "somewhat relevant (2)", " "relevant (3)",* to *"very relevant (4)"*. The mean score for each item resulted from their rating was used as an index for the degree of content validity. The mean scores varied between values of 3.5 and 4.0 which put items in the relevant to very relevant category. After a pilot study, those items with lower ratings were revised for problems in language, content, and directions.

Test Reliability

The internal reliability was estimated based on the average correlation among the test items. The K-R 20 formula (Richardson & Kuder, 1939) was employed to

compute the internal reliability through analyzing each test itemcontained in the immediate posttest during the pilot study. After the K-R 20 was performed, a coefficient alpha of 0.6047 was obtained. Unfortunately, due to experimenter's oversight, these data, plus additional item analyses data, were not used to revise the test prior to administration of the full study.

Hypotheses

Main Effects. It was expected on both the immediate and delayed posttests that explanatory feedback group would score better than either KCR or KOR feedback group and KCR feedback group would score better than KOR feedback group (explanatory feedback group > KCR feedback group > KOR feedback group) with respect to (a) overall correct responses; (b) the conditional probability of a correct response on a test given that an incorrect response was made during practice and (c) higher score on the attitude questionnaire.

With respect to the conditional probability of an incorrect response on a test given that an incorrect response was made during practice, it was expected that on both the immediate and delayed posttests that the explanatory feedback group would have a lower probability of repeating errors than either KCR or KOR feedback group and KCR feedback group would have a lower probability of repeating errors than KOR feedback group (explanatory feedback group < KCR feedback group < KOR feedback group). It was expected on both the immediate and delayed posttests that groups receiving a second try (treatment 4, 5, 6) would score better than those who received a single try (treatment 1, 2, 3) with respect to (a) overall correct responses; (b) the conditional probability of a correct response on a test given that an incorrect response was made during practice and (c) higher score on the attitude questionnaire.

Interaction Effects. It was expected on both the immediate and delayed posttests that participants receiving explanatory feedback coupled with a second try (treatment 6) would score better than all other groups and participants receiving KCR feedback coupled with a second try would score better than those who received KOR feedback in combination with a second try with respect to (a) overall correct responses; (b) the conditional probability of a correct response on a test given that an incorrect response was made during practice and (c) higher score on the attitude questionnaire.

With respect to the conditional probability of an incorrect response on both the immediate and delayed posttests given that an incorrect response was made during practice, it was expected that explanatory feedback with a second try group would score lowest and KCR feedback with a second try group would have a lower probability of repeating errors than KOR feedback with a second try group.

Procedure

This study was conducted in a normal class period across three class periods, in three weeks. This study was conducted with the following steps:

1. One week prior to the experiment, a pretest was administered to those who decided to participate. Participants then were grouped into high, medium, and low prior knowledge groups based on their pretest performance. Participants in each of these three groups were randomly assigned to one of the six treatments.

2. The following week, the lesson was administered. Participants in each of the six treatments received the instruction through a CAI module and took the

immediate posttest and the paper-and-pencil attitude questionnaire. All participants were expected to finish in 1 hour.

3. A delayed posttest was administered one week after the experiment had been conducted.

Data Analyses

Overall analyses. A series of analyses of variance on each dependent variable was performed to determine which of these variables are statistically significant. If a significant ANOVA F were found, a series of Tukey's post hoc tests were performed to determine which treatments differed significantly from one another. The level of significance (p) was set at 0.10 in making decision whether to accept or reject the null hypotheses.

Analyses of conditional probabilities. The analyses of conditional probabilities were performed in accordance with methodology developed by Kulhavy (1977):

1. The conditional probability of a correct response on a test (on the immediate test: **Rit,** on the delayed posttest: **Rdt**) given that an incorrect response was made during practice **(W1)** is the proportion consisting of the total of number of the responses which were correct on the test and were incorrect during practice, **(Rit ∩Wl)** and **(Rdt ∩Wl)**, divided by the total number of incorrect responses made during practice. This conditional probability can be expressed by:

P(Rit / Wl)= number of (Rit∩Wl) / number of W1

P(Rdt / Wl)= number of (Rdt∩Wl) / number of W1

2. The conditional probability of an incorrect response on the test (on the immediate posttest: **Wit** and on the delayed posttest: **Wdt**) given that an incorrect response was made during practice, **P(Wit/Wl)** and **P(Wdt/W1)**, is the proportion consisting of the total of the number of responses which were incorrect on the test and were also incorrect during practice, **(Wit ∩Wl)** and **(Wdt ∩Wl)**, divided by the total number of incorrect responses made during practice. This conditional probability can be expressed by:

P(Wit / Wl)= number of (Wit∩Wl) / number of W1

P(Wdt / Wl)= number of (Wdt∩Wl) / number of W1

In order to test for statistical difference between the six treatment groups, the proportional data was transformed by using the arc sine function (Dowdy & Wearden,1983). All statistical analyses were performed by using the SAS programs on an IBM 3081.

Results

Descriptive Data

Seven measures were used in this study. A summary table of the means and standard deviations for all participants on each dependent variable is presented in Table 1, and a summary of the the means and standard deviations of each of the six treatments on each dependent variable is presented in Table 2 and 3.

(Insert Table 1, 2 and 3 about here)

Hypotheses for Main Effects: Feedback Factor

Overall correct responses on the two posttests. The results of ANOVA (Table 4) revealed a significant difference in the three feedback groups with respect to the overall correct responses on the immediate posttest, F (2, 152) = 2.47, $p < 0.10$. Tukey's post hoc test revealed a significant difference between the explanatory feedback group and the KOR feedback group, indicating that explanatory feedback was significantly superior to KOR feedback in producing correct responses on the immediate posttest. Although the results revealed that the pattern of means of the explanatory feedback group and the KCR feedback group were in the predicted direction, the difference was not significant. Also, the mean score of the KCR feedback group was higher than the KOR feedback group, however, the mean difference between these two groups was not significant either (see Table 2 and Table 3). With respect to overall correct responses on the delayed posttest, the results failed to reveal a significant difference between the three feedback groups, indicating that students performed similarly on the delayed posttest no matter what type of feedback they received during practice.

(Insert Table 4 and 5 about here)

Attitude toward the instruction. With respect to participants' attitude toward the instruction, the results failed to reveal any significant difference between the three different feedback groups, indicating that students had similar attitudes towards the instruction in spite of the type of feedback message they received during practice.

The analyses of P(Rit/Wi) and P(Rdt/Wi). Regarding the means of the probability of correcting an incorrect response during practice on the immediate and delayed posttest, the results did not reveal a significant difference between the three feedback groups. Such results indicated that the effects of KOR, KCR, or explanatory feedback were similar in increasing the probability of changing an initial practice error to a correct response on the immediate and delayed posttest.

The analyses of P(Wit/Wi) and P(Wdt/Wi). Regarding the means of the probability of repeating an initial practice error on the immediate posttest, the result did not reveal a significant difference between the three feedback groups. Such result indicated that the effects of KOR, KCR or explanatory feedback were similar in reducing the probability that an practice error would occur again in the immediate posttest. However, the means of the probability of repeating an initial practice error on the delayed posttest did reveal a significant difference between the three feedback groups, F (2, 125) = 0.03, $p < 0.10$. Tukey's post hoc test revealed that the difference between the explanatory feedback group and the KCR feedback group was significant, indicating that explanatory feedback was significantly superior to KCR feedback in reducing the probability of repeating a practice error on the delayed posttest.

Although the results revealed that the explanatory feedback group produced a lower probability of repeating errors than the KOR feedback group and the KCR group produced a lower probability of repeating errors than the KOR group, significant differences were not revealed by the post hoc test (see Table 2, 3 and 4).

Hypotheses for Main Effects: Tries Factor

Overall correct responses on the two posttests. Regarding the overall correct responses measures, the results of ANOVA failed to reveal a

significant difference between the two tries groups either for the immediate posttest or for the delayed posttest. Such results indicated that learners produced similar posttest performance no matter how many tries, one or two, followed their errors during practice.

Attitude toward the instruction. With respect to learners attitude toward the instruction, the results did not reveal any significant difference between the two different tries groups, indicating that students had similar attitudes toward the tries factor whether they received a single or a second try during practice.

The analysis of P(Rit/Wl) and P(Rdt/Wl). Likewise, regarding the means of the probability of a correct response on the immediate posttest or the delayed posttest given that an incorrect response was made during practice, the results did not reveal a significant difference between the two tries groups. Such results indicated that the effects of one or two tries were similar in increasing the probability of changing an initial error to a correct response on both the immediate and delayed posttests.

The analysis of P(Wit/Wl) and P(Wdt/Wl). Regarding the means of the probability of repeating an initial practice error on the immediate or the delayed posttest, the result did not reveal a significant difference between the two tries groups. Such results indicated that the effects of one or two tries were similar in reducing the probability that an practice error would occur again on both the immediate and delayed posttests.

Interaction Effects

In the analyses of interaction effects, no significant interactive effects were found between levels of feedback and number of tries on all dependent variables involved in this study, indicating that number of tries was not differentially effective across levels of feedback on any of the dependent variables.

Summary

The results indicated that there was a significant difference in the explanatory feedback group and the KOR feedback group regarding the production of correct responses on the immediate posttest. The explanatory feedback showed superiority over the KOR feedback in raising the total number of correct responses on the immediate posttest. The results also indicated a significant difference between the explanatory feedback group and the KCR feedback group while measuring the conditional probability of reducing a practice error on the delayed posttest. The explanatory feedback also seemed to be better than the KCR feedback in avoiding a previous practice error on the delayed posttest. Other measures on the effects of the feedback factor failed to indicate any significant results, and no significant results were found from the measures for the tries factor or for the interaction effect.

Discussion and Recommendations

Main Effects: Feedback Factor

Explanation and discussion of the results. Among the findings discussed above, the first significant result: the superiority of explanatory feedback over KOR feedback on overall correct responses on the immediate posttest, seems to indicate that explanatory feedback supplies learners with the corrective information so that they can determine why a correct answer is right and why an

As error occurs, thereby producing more correct responses on the immediate posttest. for the second significant result, the superiority of explanatory feedback over KCR feedback on reducing the probability of repeating an error on the delayed posttest, it also seems to indicate that explanatory feedback allows learners to incorporate the corrective information into their ongoing information-processing procedure so that they will not repeat an previous error. This finding was particularly interesting in that it was found on the delayed posttest.
Although patterns of means were in the predicted direction on all measures examining effects of levels of feedback (explanatory feedback > KCR feedback > KOR feedback), the significance of these differences were inconsistently significant. Possible explanations for these effects are twofold: (a) the learning motivation was suppressed by the difficulty of the learning materials and (b) low reliability of the testing instrument interjected more error variance. As matter of fact, the grand mean across all treatment groups was 7.24 for the immediate posttest, 6.25 for the delayed posttest, with total possible scores of 15 for each measure. So the average performance across all treatment groups was quite low. This indicated the level of the difficulty and complexity of the instruction, practice questions and test items may have been beyond the ability level of most participants. Students may not have maintained the level of attention and motivation expected from them throughout the whole instruction. It is necessary to point out that the instructional materials used in the current study were intended to be written at a relatively difficult level in order to ensure some errors would occur during practice so that feedback could be utilized.

It is also necessary to emphasize that according to Polya (1957), successful problem solving behavior requires stages of understanding the problem, devising a plan, carrying out the plan and evaluating the effectiveness of the plan. He further cites the importance of the effective aspects of problem solving such as motivation, determination and curiosity in problem solving performance. In this study, if learners had difficulty in understanding or acquiring the learning information, they might not have been fully motivated to complete the whole lesson or to exercise any of the four problem solving stages in order to successfully answer the practice questions. If so, explanatory feedback given after a practice error may have worked as a remedial instruction. In such a case, if a test was administered immediately after the lesson, those who received explanatory feedback during practice may still have been able to recall the corrective information to produce the correct response on that test. In the same case, those who received KCR feedback may simply have memorized the correct answer and matched that answer with an answer similar in form. As for learners in the KOR feedback group, if they were unmotivated or unable to learn, a simple message such as "You are right" or "You are wrong" may have been insufficient to aid them to analyze an error or to reason out the correct answer during practice, requiring more mental effort than they were able or willing to apply. This may have resulted in poor performance on the immediate posttest. These reasons may be responsible for the finding that a significant difference was only found in overall correct responses on the immediate posttest between the explanatory and the KOR feedback groups. And these reasons may also be responsible for why the mean difference of the overall correct responses on the immediate posttest between the explanatory and the KCR feedback groups was in the predicted direction but not great enough to reach the statistical difference.

As for why explanatory feedback was significantly better than KCR feedback in reducing the probability of repeating a practice error on the delayed posttest, the reasons may be that if students did not maintain a high level of attention or motivation throughout the entire CAI lesson, they might have been unable to employ their learning to answer the practice questions and might have missed most of the questions. If this were the case, the more practice errors, the more explanatory information would be received by students in the explanatory feedback group. In the same case, a number of correct answers would be received by students in the KCR feedback group and the message containing fairly strong language such as "You are wrong" would be repeatedly received by students in the KOR feedback group. As a result, when the delayed posttest was administered, students received explanatory feedback might not have been able to apply their learning to determine the correct answer, however, they might have been able to employ the explanatory feedback information sufficiently to avoid the previous error. Those who in the KOR feedback group might not commit the same previous error because they were told "You are wrong" before.

As for learners in the KCR feedback group, because they were only provided with the correct answer, they might have easily forgotten the correct answers due to their inability to understand why the correct answer was right. This reason might have been responsible for why, with respect to the measure, probability of repeating a practice error on the delayed posttest, the explanatory feedback group scored significantly lowered than the KCR feedback group and the KOR feedback group scored slightly lower than the KCR feedback group (the difference between the KCR and KOR groups was not great enough to be significant). Again, if students were not motivated to learn or had difficulty in comprehending the materials, whatever they read from the CAI lesson would have been faded quickly from their memories. As a result, all the three feedback groups might have performed poorly and similarly on a posttest that was delayed. This reason might have been responsible for the failure to reach a significant difference on the measures of overall correct responses and the probability of changing a practice error to a correct response on the delayed posttest among the three feedback groups. It might be that because students more often had failure rather than success with the learning materials, they might have had less positive attitudes toward the instruction in spite of the different treatments they received. On the measure of students' attitude toward the instruction, the mean difference among the three feedback groups was not statistically significant, however, in terms of mean differences, students in the explanatory feedback group scored higher on the attitude questionnaire than did students in the KCR and KOR feedback groups, and students in the KCR feedback group scored higher on the attitude questionnaire than did those who in the KOR feedback group.

The above assumptions can be supported by the following evidences. The subjects involved in this study were students enrolled in the Computer Literacy course. Most students take the Computer Literacy course because it is required by their departments. Consequently, many important characteristics such as need for achievement, level of interest, attention and motivation might be different in other populations. Besides, results obtained from the pretest revealed that ninety percent of participants were considered as low prior knowledge students. From analyzing students' preassessment information, it was found that most of the participants had never have any experience with computers. It may be that because most participants did not have any prior knowledge on computers and programming languages, their learning motivation might have been seriously suppressed. They

might have even been anxious about learning this content, further depressing their motivation and performance. Comments made on the attitude questionnaire confirmed the above assumption. These comments indicated that students felt that both the instructional materials and the practice questions were fairly hard. Those comments also revealed that students had difficulty in learning from the instructional materials and seemed to have troubles in completing the practice questions during the class time. The test items might have been too hard for most participants, and there might be some inadequacy in the test item for the reliability analysis of this instrument revealed a fairly low reliability coeffcient (0.6047).

Recommendations for future studies. Based upon the above discussion, a number of recommendations are made: first of all, on one hand, differences which existed among the sample such as level of learning motivation, ability and need for achievement should be seriously taken into consideration when investigating the effects of different types of feedback. On the other hand, future studies are recommended to examine how the level of difficulty of instructional materials affects the learning motivation and, consequently the facilitating effects of different types of feedback. Think-aloud interviews are recommended so that the researcher can obtain information as to how learners utilize the feedback information. Self-report measures of effort and motivation might also be used to obtain information to substantiate the above assumptions .

Secondly, future research is necessary to determine what is the sufficient and adequate amount of feedback information that would be beneficial for learning. Practically, it is recommended that instructional designers reconstruct explanatory feedback into two specific types: (a) the corrective feedback, which contains corrective information and is primarily for helping the learner to locate an error and (b) the remedial feedback, which contains brief instruction as to hint the learner to search for the correct answer. Also recommended is that both the corrective and remedial feedback should be included in any CAI lesson, and learners should be allowed to choose the specific type of feedback they really need. Of course, researchers should examine the comparative benefits of the corrective and remedial feedback on the effects of (a) correcting an initial error to a correct response on a later performance, (b) maintaining an initial correct response on a later performance, and (c) decreasing the probability of repeating an initial error on a later performance.

Main Effect: Tries Factor

Explanation and discussion of the results. Unexpectedly, with respect to all dependent variables involved in this study, the results failed to support the hypotheses that a second try upon a missed practice practice would be more effective than a single try. As a matter of fact, only means of the attitude toward the instruction were in the predicted direction.

One of the possible reasons for these unexpected results might be that, as discussed, students involved in this study might have been unmotivated to maintain the level of attention expected from them throughout the CAI learning. Students might have passively gone through the whole CAI lesson without paying attention to the learning content. When they were asked to do the practice questions, they might have experienced frustration due to their inability to understand the questions. They might have expected to finish the practice questions as soon as possible. If so, during the first try, learners might

have no idea about how to find the correct answer. After an error, feedback might have been insufficiently remedial to correct misconceptions of rules and concepts. Thus, during the second try, even with the help of feedback, they might not have been able to eliminate the previous error or to determine the correct answer.

Very possibly, students might have been seriously confused by the feedback information and then might have made an extra error during the second try. In this case, students receiving a second try after an error might have resulted in worse posttest performance than those who received a single try. Those who received a single try after after an error did not have an additional opportunity to make an extra error, therefore this might have reduced the probability of repeating a previous error on a later performance. These findings were consistent with the findings obtained in Hodes'(1984) study in which an extra corrective opportunity upon the missed item was not superior to a single try upon the same item in raising the posttest scores.

Recommendations for future studies. Future studies are needed to determine the level of effort and motivation that might be necessary for second try to be effective. The question of whether the instructional event such as a second try provided during learning or practicing is necessary should be answered. Further studies investigating the effects of second try and its pairing with feedback should be conducted to ascertain if this study's results are generalizable to other populations and other content. These future studies should include some important conditional probability measures, which were not included in this study. The suggested conditional probability measures may include the probabilities of (a) maintaining a correct response made during a second try on a later performance and (b) repeating an error made during a second try on a later performance. These measures can provide information as to whether a second try can help learners to change a previous error to a correct response and to maintain that correct response on a later performance.

Interaction Effects

Explanation and discussion of the results. In the analyses of interaction effects, results failed to reveal any significant results. One of the possible reasons for this might be a result of the unexpected findings obtained from the analysis of the tries factor. In the analysis of the tries factor, only the means of the attitude toward the instruction were in the predicted directions. Without the predicted effects of the tries factor, the interaction would not be expected.

Recommendations for future studies. The major expectation of this study was that a combination of explanatory feedback with a second try would provide learners with corrective information as well as an extra opportunity to review the feedback information and to redo the missed question, thereby producing a superior posttest performance. The findings did not support this prediction. Future studies are necessary to determine how much and what kind of corrective information paired with a second try can really make a difference compared to simple KOR or KCR feedback paired with a second try on error correction. Future research is also needed to investigate when and why feedback paired with a second try should be given when considering other important variables such as learning motivation and other learners' characteristics.

Conclusion

In the analysis of feedback factor, the findings indicated that explanatory feedback was more powerful than KOR feedback in helping students maintain the

correct responses on the immediate posttest. Explanatory feedback was also more powerful than KCR feedback in preventing students from repeating a previous error on a delayed posttest. No significant results were obtained either from the analyses of the tries factor or for the interaction effects.

One of the possible reasons for these spotty and inconsistent results might be that learners did not maintain a high level of learning motivation. This low attention and motivation level might have been due to the level of difficulty and complexity of the instruction which seemed to be beyond the ability level of most participants. The findings from this study indicate future research is necessary on determining how learners utilize feedback information and how much information is sufficient and appropriate to encourage a change in errors into correct responses. Future study is also needed to determine how the difficulty of instruction, the level of effort and motivation and learners' characteristics influence the effectiveness of different types of feedback and their pairing with a second try on error correction.

References

Ausubel, D. P. (1968). Educational psychology: A cognitive view, New York:Holt, Rinehart and Winston, Inc.

Buss, A. H., & Buss, E. (1956). The effect of verbal reinforcement combinations on conceptual learning, Journal of Experimental Psychology, 52, 283-287.

Carter, J. (1984). Instructional learner feedback: A literature review with implications for software development, The Computing Teachers, 12(2), 53-55.

Dowdy, S. & Wearden, S. (1983). Statistics for research, p. 299-301, New York:John Wiley & Sons, Inc.

Gagne, R. M., & Briggs, L. J. & Wager (1987). Principles of instructional design (2nd ed.) New York:Holt, Rinehart and Winston.

Gilman, D. A. (1969). Comparison of several feedback methods for correcting errors by computer assisted instruction, Journal of Educational Psychology, 60, 503-508.

Hodes, C. L. (1984-1985). Relative effectiveness of corrective and noncorrective feedback in computer assisted instruction on learning and achievement. Journal of Educational Technology System, 1(4), 249-254.

Hudson, R. C. (1981). Feedback: Administered by a computer, Dissertation Abstracts International, 42, abstract no. 4420A.

Kulhavy, R. W. (1977). Feedback in written instruction, Review of Educational Research,47, (1), 211-232.

Mayer, R. E. (1976). Some conditions of meaningful learning for computer programming: advanced organizer and subject control of frame order. Journal of Educational Psychology, 68, No. 2, 143-150.

Moore, J. W., & Smith, W. I. (1965). Role of knowledge of results in programmed instruction. Psychological Reports, 14, 407-423.

Park, 0. (1984). Empirically Based Procedures for Designing a Response-Sensitive Sequence in Computer-Based Instruction: An Example From Concept-Teaching Strategies. Journal of Computer-Based Instruction, 11(1), 14-18.

Phye, G. D. (1979). The Processing of Informative Feedback about Multiple-Choice Test Performance, Contemporary Educational Psychology, 4, 381-394.

Polya, G. (1957). How to Solve it (2nd ed.), New York: Doableday.

Roberts, F. C., Park, 0. (1984). Feedback strategies and cognitive style in computer-based instruction, The Journal of Instructional Psychology, vol. 11, No.2.

Roper, W. J. (1977). Feedback in computer assisted instruction. Programmed Learningand Educational Technology, 14, 43-49.

Ross, R. W. (1984). Matching the lesson to the student: Alternative adaptive designs for individualized learning systems, Journal of Computer-Based Instruction, 11, 42-48.

Ross, 5. M., Rakow, E. A. et al (1980). Instructional adaption for selfmanaged learning systems, Journal of Computer-based instruction, 11, 42-48.

Saloman, G. (1972). Heuristic models for the generation of aptitude treatment interaction hypotheses. Review of Educational Research, 42 (3), 327-343.

Sassenrath, J. M. (1975). Theory and results on feedback and retention. Journal of Educational Psychology, 67, 894-899.

Skinner, B. F. (1961). Why we need teaching machines. Harvard Educational Review, 31 377-398.

Skinner, B. F. (1968). The Technology of Teaching, New York:Appleton Century-Crofts making.Educational Technology, 19(1), 20-26.

Spock, P. (1988). The Effect of feedback, correctness of response, and confidence of response on a rule-learning task using computer-assisted instruction, Doctoral Dissertation, the University of Texas at Austin, Austin, TX.

Sternberg, R. J. (1983). Criteria for intellectual skills training. Educational Researcher, 12, 6-12.

Table 1: Summary of Means and Standard Deviations for All Dependent Variables

Dependent Variables	N	M	SD
Immediate Posttest	158	7.244[a]	2.83
Delayed Posttest	132	6.25[b]	3.30
Attitude Questionnaire	160	30.06[c]	5.31
P(Rit/W1)	158	0.79	0.32
P(Wit/W1)	158	0.77	0.32
P(Rdt/W1)	110	0.57	0.36
P(Wdt/W1)	131	1.00	0.35

[a] Immediate posttest contained 15 multiple choice questions.
[b] Delayed posttest contained 15 multiple choice questions.
[c] Attitude questionnaire contained 10 questions (highest possible score was 50; higher score indicates more favorable attitude).

Table 2: Summary of Means and Standard Deviations of Six Treatments for Immediate Posttest, Delayed Posttest and Attitude Questionnaire

Level of Feedback

Number of Tries		KOR	KCR	Explanatory
One	Immediate Posttest	N = 27 M = 6.40 SD = 2.35	N = 27 M = 7.74 SD = 2.39	N = 25 M = 7.92 SD = 3.23
	Delayed Posttest	N = 24 M = 5.91 SD = 2.74	N = 20 M = 7.15 SD = 3.37	N = 20 M = 6.90 SD = 4.15
	Attitude Questionnaire	N = 28 M = 29.28 SD = 4.67	N = 27 M = 29.55 SD = 6.29	N = 25 M = 30.72 SD = 4.65
Two	Immediate Posttest	N = 25 M = 6.72 SD = 2.63	N = 29 M = 6.62 SD = 2.96	N = 25 M = 7.64 SD = 2.88
	Delayed Posttest	N = 22 M = 5.77 SD = 3.20	N = 24 M = 5.08 SD = 2.63	N = 22 M = 6.95 SD = 3.44
	Attitude Questionnaire	N = 25 M = 28.72 SD = 4.56	N = 29 M = 29.96 SD = 5.90	N = 26 M = 31.26 SD = 5.82

2

Table 3: Summary of Means and Standard Deviations of Six Treatments for All Conditional Probability Measures

Number of Tries		Level of Feedback: KOR	KCR	Explanatory
One	P(Rit/W1)	N = 27 M = 0.75 SD = 0.26	N = 27 M = 0.86 SD = 0.33	N = 25 M = 0.81 SD = 0.36
	P(Rdt/W1)	N = 27 M = 0.54 SD = 0.23	N = 27 M = 0.57 SD = 0.39	N = 25 M = 0.60 SD = 0.47
	P(Wit/W1)	N = 24 M = 0.79 SD = 0.27	N = 20 M = 0.70 SD = 0.33	N = 20 M = 0.75 SD = 0.36
	P(Wdt/W1)	N = 24 M = 1.03 SD = 0.23	N = 20 M = 0.99 SD = 0.39	N = 20 M = 0.96 SD = 0.47
Two	P(Rit/W1)	N = 25 M = 0.78 SD = 0.30	N = 29 M = 0.73 SD = 0.24	N = 25 M = 0.81 SD = 0.36
	P(Rdt/W1)	N = 25 M = 0.53 SD = 0.33	N = 29 M = 0.47 SD = 0.34	N = 25 M = 0.60 SD = 0.47
	P(Wit/W1)	N = 20 M = 0.78 SD = 0.30	N = 24 M = 0.83 SD = 0.23	N = 21 M = 0.75 SD = 0.36
	P(Wdt/W1)	N = 20 M = 0.96 SD = 0.33	N = 24 M = 1.14 SD = 0.24	N = 21 M = 0.96 SD = 0.47

Table 4: Summary of Analyses of Variance for All Dependent Variables

Variables	F	df	p
Types of Feedback (F)			
Immediate Posttest	2.47	2, 152	0.080*
Delayed Posttest	1.29	2, 126	0.279
Attitude Questionnaire	1.81	2, 154	0.167
P(Rit/W1)	0.01	2, 152	0.909
P(Wit/W1)	0.09	2, 152	0.917
P(Rdt/W1)	1.98	2, 125	0.142
P(Wdt/W1)	2.58	2, 125	0.079*
Numbers of Tries (T)			
Immediate Posttest	0.68	1, 152	0.411
Delayed Posttest	−19	1, 126	0.299
Attitude Questionnaire	0.02	1, 154	0.877
P(Rit/W1)	0.106	1, 152	0.305
P(Wit/W1)	1.19	1, 152	0.277
P(Rdt/W1)	0.00	1, 125	0.949
P(Wdt/W1)	0.03	1, 125	0.852
F * T			
Immediate Posttest	0.95	2, 152	0.401
Delayed Posttest	1.40	2, 126	0.250
Attitude Questionnaire	0.17	2, 154	0.845
P(Rit/W1)	0.95	2, 152	0.388
P(Wit/W1)	0.65	2, 152	0.525
P(Rdt/W1)	0.94	2, 125	0.395
P(Wdt/W1)	1.64	2, 152	0.198

* $p < 0.10$

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Table 5: Tukey's Post hoc test for Feedback Groups on the Immediate Posttest

	Differences between Means		
Variables	KOR Feedback	KCR Feedback	Explanatory Feedback
KOR Feedback	0	0.60	1.22*
KCR Feedback	0.60	0	0.61
Explanatory Feedback	1.22*	0.61	0

* $p < 0.10$